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Robert Hosfield

1. Introduction

The transmission of knowledge, teaching and learning mechanisms and the role of social learning in determining what is transmitted have been extensively considered in recent years. Studies have explored primate tool-use and behaviour (e.g. Boesch 1993; Boesch and Boesch 1993; Whiten 2000), cultural traditions and variations (e.g. Boyd and Richerson 1985; Cavalli-Sforza and Feldman 1981; Guglielmino et al. 1995; Shennan 2002; Shennan and Steele 1999), and the nature of transmission and learning (e.g. Boyd and Richerson 1988; Rowlands 1993; Tindall l976). These studies have highlighted both the complexities of learning and knowledge transmission processes, and their implications both for what humans learn and how they learn it: and therefore their short and long-term impacts upon human behaviour and material culture.

This paper explores the issue of knowledge transmission and learning with regard to craft skills: the acquisition of knowledge, patterning in material culture, and the detection of modes of transmission on the basis of material culture patterning in the archaeological record. The observations of Shennan and Steele (1999:376) and Shennan (2002:49) that transmission relating to the learning of craft techniques appears to be mainly if not entirely vertical/oblique rather than horizontal are tested against an expanded data set (ethnoarchaeological, archaeological and ethnographic), and the impacts of these modes of transmission are explored with respect to the degree of conservatism or innovation seen in the resultant material culture products. Finally the paper concludes by exploring how improved understanding of the processes of craft skills learning can assist in the interpretation of material culture patterning in the archaeological record.

2. Case Studies

72 case studies provided data for both the mode of transmission associated with craft skills learning and the nature of the material culture patterning. In a number of instances (e.g. for the Hidatsa of North Dakota (Bowers 1965) and the Kalinga of the Philippines (Longacre 1981; Stark and Longacre 1993)), two cases were derived from a single group or culture, as distinctions were made between the varied impacts of vertical transmission and horizontal transmission upon material culture. The case studies were collated from a wide range of sources, including the Human Relations Area Files (HRAF) databases for ethnography and archaeology (HRAF 2002, 24 September, http://www.yale.edu/hraf/; Table 1). Selection was based on the documentation of both the mode of cultural transmission (Section 2.1) and material culture patterning (Section 2.2).

2.1 Modes of Transmission

The modes of cultural transmission defined by Cavalli-Sforza and Feldman (1981), and since re-used by a number of other authors (e.g. Hewlett and Cavalli-Sforza 1986:923–924, Fig. 1; Shennan 2002:48–51, Fig. 4), formed the basis for classifying and identifying the routes of craft skills learning in the case study literature:

- Vertical (parent–to–child): the closest to biological transmission, highly conservative and likely to result in slow cultural evolution. Shennan and Steele (1999:376) observed in their survey of craft techniques learning that vertical transmission commonly occurs between parents and same gender offspring.
- Oblique: no genetic parallel, involves learning from non-parents of the older generation (Shennan 2002:49).
- Master/apprentice (a specialist sub-set of oblique transmission): the division drawn here between oblique and master/apprentice transmission reflects the evidence in the case study literature for the

distinctive conditions and circumstances associated with craft apprenticeships (e.g. the removal of individuals from their homes and their re-location within the master's house (Epstein 1998:688–693; Silver 1981:43–44)).

- Horizontal (peers, individuals from other communities/social units, foreign traders): Cavalli-Sforza and Feldman (1981) viewed this as a typically "cultural" form of transmission, occurring between two individuals within the same generation, in which individuals learn from their contemporaries.

A limitation of the data sources concerned their frequent failure to distinguish between vertical, oblique, and master/apprentice modes of transmission: Van der Grijp's (1995) investigations of basket making and mat weaving on Tonga noted that girls learn these skills at school (Hewlett and Cavalli-Sforza's (1985:924) one-to-many transmission), but that they also learn the finer points of the crafts from experienced sisters and aunts (oblique transmission), and mothers (vertical transmission). No distinction was drawn between these different teaching and learning models, and although it may be that, for example, the maintenance of traditions was emphasised by all of the transmitters, this is unknown. These data limitations were also sometimes evident with regard to distinctions between vertical, oblique and horizontal transmission. For example, Navajo weaving was learnt from parents and aunts (vertical and oblique transmission), but there was also a considerable history of borrowing and modifying traits (e.g. weaving patterns) from neighbouring cultures (horizontal transmission) (Downs 1972; Kent 1985; Kluckholn 1946; Newcomb 1964). Nonetheless, the available data generally supported Shennan and Steele (1999:376) in that 73.6% (n=53) of cases consisted of vertical, oblique or master/apprentice modes of transmission (or some mixture thereof).

2.2 Identifying Evidence for Conservatism & Innovation in Material Culture

Unfortunately, it was extremely rare to find detailed data regarding the degree of conservatism/innovation involved in the learning and practice of particular crafts (e.g. data illustrating the changing frequencies of material culture types over time). Consequently it was necessary to base inferences concerning the degree of conservatism on a number of lines of evidence.

The documentation of distinctive material culture types at the level of individual social units, in comparison with surrounding units, was interpreted as evidence for conservative practices and the maintenance of traditions[i] (it is acknowledged that these patterns could also reflect independent experimentation and innovation within the individual social units, combined with a lack of horizontal transmission, although it is proposed here that such activity might be expected to result in at least partial duplication and overlap of styles, forms and/or techniques between different units). The units could be individual households (e.g. Bowers 1965), lodges (e.g. Bowers 1950), compounds (e.g. DeBoer 1984), villages (e.g. Balfet 1981) or valleys (e.g. MacKenzie 1991). Anecdotal references to the maintenance of old styles or traditions (e.g. Deal 1998; Stanislawski 1977:389–390, 1978:214; Stanislawski and Stanislawski 1978:63) or to experimentation and change in material culture (e.g. Deal 1998:26–37; Kent 1985), were interpreted as evidence for conservatism and innovation respectively. Comparisons (anecdotal, typological or quantitative) between modern materials and historical/archaeological assemblages (e.g. DeBoer 1984:557; Hurt 1942:94–95; Nash 1970:48–49), provided evidence for either conservatism or innovation. References (anecdotal or documented) to new forms, styles, designs, decorations and/or techniques in material culture (e.g. Aronson and Fournier 1993; Nicholls 2000; Stark and Longacre 1993) provided evidence for innovation.

References to social practices or traditions (e.g. production secrets, access to manufacturing rights and related knowledge (e.g. Bowers 1950; MacKenzie 1991:104–106)), or social attitudes towards innovation and change (e.g. Hayden 1987; Kent 1985; Mead 1928), were interpreted as evidence for conservatism or innovation as appropriate. In the case of social attitudes, there were often clearly defined pro- (e.g. Kent 1985; Mead 1928) and anti-innovation stances (e.g. Hayden 1987). The maintenance of production secrets amongst selected individuals within a community or craft production unit was commonly only associated with the maintenance of traditions, rather than with innovation and change.

The data permitted the construction of two basic categories for material culture patterning: conservatism (n=46, 64%; defined as the maintenance of traditions and/or little evidence of change in material culture) and innovation (n=26, 36%; defined as experimentation and/or the introduction of new traits in material culture). Since the key goal of the paper was to explore the relationships between modes of transmission and material culture patterning, it was also desirable to further split the innovation cases (n=26) into experimentation (n=12, 46%: defined as the independent invention of new traits) and borrowing (n=14, 54%: defined as the external introduction of new traits, and therefore closely associated with the horizontal mode of transmission). The innovation category (and sub-categories) also makes no distinction between the types of possible changes in material culture, although it was evident that changes included new types or forms (e.g. Nicholls 2000), new designs (e.g. Lamb 1975), patterns (e.g. Ottenberg 1975) or decorations, or new techniques and practices (e.g. Hayden 1987). In many cases these data were either not specified, or data distinguishing between multiple types of changes were not available (e.g. Stark and Longacre (1993) discuss in general terms the appearance of new forms, decorations and styles in the pottery of the Kalinga during the 1970s and 1980s).

2.3 Craft Skills

For the purposes of this paper craft skills are defined as those motor and cognitive skills required for the production of end products through the manipulation of raw materials by the use of tools, including the human hand (after Roux et al. 1995:63; Robertson 1961:27). The case studies' end products could be for either domestic use or sold through a non-domestic setting (e.g. a market place), while the raw materials and end products are all characteristic of (although not necessarily restricted to) pre-industrial societies. The key craft skills identified in the case studies were pottery, weaving, lithics (stone tool production, including the production of glass artefacts using lithic knapping techniques), carving, and metalworking.

Region	Case Studies	References
Africa		
	Aka, Central African Republic	Hewlett and Cavalli-Sforza (1986)
	Asante, Bonwire, Ashanti & Ewe, Ghana	Lamb (1975); Rattray (1927)
	Igbo, Iseyin, Ooko, Yoruba & Zaria, Nigeria	Allen (1983); Bray (1969); Lloyd (1953); Nicholls (2000); Ottenberg (1975); Roy et al. (2000)
	Kalahari San, Southern Africa	Wiessner (1983)
	Kisi, Tanzania	Kramer (1985); Waane (1977)
	Lozi, Zambia	Hodder (1981)
	Maghreb, North Africa	Balfet (1981)
	Moba, Togo	Kreamer (2000)
	Toumra, Darfur, Sudan	Haaland (1985)
	Wolayta, Ethiopia	Silverman (2000)
	Zaghawa, Kebkebiya, Sudan	Tobert (1985)
Asia		
	Iban, Sarawak, Malaysia	Mashman (1991); Sandin (1980)
	Ifugao, Northern Luzon, Philippines	Centre for Women's Resources (Philippines) (1999); Kok (1979); Lambrecht (1958); Tolentino Jr. (2001)
	Kalinga, Philippines	Kramer (1985); Longacre (1981); Stark and Longacre (1993)
	Khambhat, India	Roux et al. (1995)
	Rajasthan, India	Kramer (1997)
	Sherpa, Nepal	Brower (1987, 1991)
	Thimi & Bhaktapur, Kathmandu Valley, India	Birmingham (1975)
	Vijayanagara, India	Sinopoli (1988)
Australasia & Pacific Islands		
	Alyawara, Central Australia	Binford and O'Connell (1984)
	Arnhem Land, Northern Australia	Jones and White (1988)
	Kitawa, Trobriand Islands, New Guinea	Scoditti (1982, 1990)
	Nakauvadra, Fijian Islands	Tippett (1968)
	Samoa	Mead (1928)

	Telefol, Central New Guinea	Ingold (2000); MacKenzie (1991)
	Tikopia, Western Polynesia	Firth (1939)
	Tonga, Western Polynesia	Van der Grijp (1995)
North & Central American		
	Klamath, California & Oregon, USA	Barrett (1910); Pearsall (1950)
	Hawaiian Islands, USA	Handy (1972)
	Amatenango, Chanal, Aguacatenango, Chamula & San Mateo Ixtatan, Mayan Highlands, Mexico & Guatemala	Deal (1998); Hayden (1987); Hayden and Cannon (1984); Hayden and Nelson (1981); Howry (1978); Nash (1970); Nelson (1987)
	New England, USA	Clarke (1939)
	Zuni, New Mexico, USA	Adair (1945)
	Mandan & Hidatsa, North Dakota, USA	Bowers (1950, 1965)
	Huichol, Northern Mexico	Deal (1998); Zingg (1938)
	Atzompa, Oaxaca, Mexico	Deal (1998); Hendry (1992)
	Otomi, Pino Suarez, Mexico	Aronson and Fournier (1993)
	Hopi & Hopi-Tewa, Navajo & San Carlos/Western Apache, South-Western USA	Adair (1945); Deal (1998); Downs (1972); Ferg (1987); Ferg and Kessel (1987); Goodwin (1942); Hartman (1987); Hurt (1942); Kent (1985); Kluckholn (1946); Newcomb (1964); Perry (1991); Roberts (1929); Stanislawski (1977, 1978); Stanislawski and Stanislawski (1978); Tschopik (1941)
	Zapotec, Yalálag, Mexico	Jopling (1977)
South America		
	Shipibo-Conibo, Peru	DeBoer (1984); DeBoer and Lathrap (1979)
	Yámana, Tierra del Fuego, Chile	Dransart (1992)

Table 1: Case studies & references

3. Analyses & Results

The nature of the data limited the range of analyses that it was possible to carry out, mainly because there was very little quantifiable data with regard to the extent of conservatism/innovation (e.g. time-frequency data for pottery typologies). Instead, the majority of the data was only appropriate for nominal or ordinal-scale variables (the test variables and data categories are summarised in Table 2). Therefore contingency tables were constructed, based on cross-tabulation between appropriate variables. X^2 analyses were applied to the data, reflecting the nominal and ordinal-scale data categories (Table 3). This enabled an exploration of the possible relationships between the modes of transmission associated with craft skills learning, patterns in the material culture, and a range of other variables. The significance level (α) for all of the X^2 tests was 0.05.

The key results of the analyses were:

1: Transmission mechanisms (Mode of transmission vs. Degree of conservatism; Mode of transmission vs. Innovation type): A significant association ($p=0.000$, Cramer's $V=0.683$; Table 3) was demonstrated between: (i) vertical (parental) transmission and conservative patterns in craft skills' material culture; and (ii) horizontal transmission and innovative patterns in craft skills' material culture. Transmission through teachers or craft masters (i.e. apprenticeship systems) was associated with a mixture of both innovative (all through experimentation: see comments below) and conservative patterns in material culture, although a very small sample size ($n=7$) is noted here. With regards to the different types of innovation, significant associations ($p=0.000$, Cramer's $V=0.926$; Table 3) were evident between vertical, master/apprentice and mixed (vertical, oblique, and/or master/apprentice) transmission and innovation by experimentation, while innovation by borrowing was predominantly (and unsurprisingly) limited to horizontal transmission (for which there was only one example of innovation by experimentation). There was little evidence for innovation by borrowing occurring amongst artisans whose learning of their craft was vertical or oblique.

Variable	Categories		Comments
Mode of transmission (V01)	(1) Vertical	(4) Mixed[1]	Mixed categories include some/all of vertical, oblique, and master/ apprentice (*Mixed*[1]) and some/all of vertical, oblique, master/apprentice & horizontal (*Mixed*[2]). See section 2.1 for further details.
	(2) Oblique	(5) Horizontal	
	(3) Master/apprentice	(6) Mixed[2]	
Degree of conservatism (V02)	(1) Conservatism	(2) Innovation	See section 2.2 for further details.
Innovation type (V03)	(1) Experimentation	(2) Borrowing	See section 2.2 for further details.
Craft skill type (V04)	(1) Pottery	(4) Wood-carving	*Lithics* category includes glass-working using lithic knapping techniques. *Other* category includes craft skills not covered elsewhere, references to generic craft skills, and cases with multiple, undistinguished craft skills.
	(2) Weaving & basketry	(5) Metalworking	
	(3) Lithics & stone-working	(6) Other	
Craft skills re-classed (V05)	(1) Additive	(3) Generic (specific craft skill data not available)	Categories defined by addition (pottery, weaving, metalworking) or subtraction (lithics, woodcarving) of raw materials during manufacturing.
	(2) Subtractive		
Social pressures? (V06)	(1) Yes	(2) No	Social pressures against innovation (yes/no)?
Frequency of production (V07)	(1) All-year round/daily/full-time	(3) Annual or less frequent	*Mixed* category is a combination of some/all of the other categories.
	(2) Seasonal/part-time	(4) Mixed	
Length of learning (V08)	(1) Less than 1 year	(3) 5–10 years	-
	(2) 1–5 years	(4) 10 years+	
No. of production stages (V09)	(1) 1–5 stages	(3) 10 stages+	Given the limitations of the data it is probable that the stated number of production stages is a *minimum* estimate.
	(2) 6–10 stages		
No. of distinct artefact types (V10)	(1) 1 type	(3) 10–25 types	Data was based on the number of distinct types listed in the case studies, and may be consistently under-estimated.
	(2) 2–10 types	(4) 25 types+	
Same sex? (V11)	(1) Yes (Females)	(3) No (Females & males)	Whether the transmitter and transmittee were the same or different (*No (Females & males)*) sex.
	(2) Yes (Males)		
Type of material culture change (V12)	(1) Type, forms, designs, patterns & decorations	(3) Mixed	*Mixed* category is a combination of both of the other categories.
	(2) Technologies, tools & techniques of production		
Observation timescales (V13)	(1) Less than 50 years	(3) 100 years+	Data based on dates and semi-quantitative references (e.g. 'three generations of change').
	(2) 50–100 years		
Settlement type (V14)	(1) Mobile campsite	(4) Town	Incorporating variations in settlement size, community structure, and economic organisation (e.g. the presence/absence, size, and function of markets).
	(2) Hamlet	(5) Village/town	
	(3) Village		
Subsistence economy (V15)	(1) Agriculture	(3) Mixed	Incorporating variations in material culture and economic/social structures. *Mixed* is a combination of both of the other categories.
	(2) Hunter-gathering		
Kinship/residence (V16)	(1) Matrilineal/matrilocal	(2) Patrilineal/patrilocal	Assessing impacts of residence patterns on learning frameworks.
Continent (V17)	(1) Americas	(3) India	-
	(2) Africa	(4) Australasia & Pacific	
Latitude (V18)	(1) Tropical	(2) Non-tropical	Defined by location between Tropics of Cancer/Capricorn (*Tropical*) and north/south of the respective tropics (*Non-tropical*).

Table 2: Data variables and categories

Test Variables		Sample Size (n)	P-value	Cramer's V
Mode of transmission (V01)	Degree of conservatism (V02)	72	0.000	0.683
Mode of transmission (V01)	Innovation type (V03)	26	0.000	0.926
Craft skill type (V04)	Degree of conservatism (V02)	72	0.511	0.244
Craft skills re-classed (V05)	Degree of conservatism (V02)	72	0.781	0.083
Mode of transmission (V01)	Craft skill type (V04)	72	0.118	0.305
Mode of transmission (V01)	Craft skills re-classed (V05)	72	0.143	0.319
Social pressures? (V06)	Degree of conservatism (V02)	18	0.004	0.671
Mode of transmission (V01)	Social pressures? (V06)	18	0.639	0.375
Frequency of production (V07)	Degree of conservatism (V02)	32	0.508	0.270
Length of learning (V08)	Degree of conservatism (V02)	24	0.758	0.222
No. of production stages (V09)	Degree of conservatism (V02)	19	0.138	0.456
No. of distinct artefact types (V10)	Degree of conservatism (V02)	27	0.542	0.282
Same sex? (V11)	Degree of conservatism (V02)	68	0.629	0.117
Mode of transmission (V01)	Same sex? (V11)	68	0.059	0.362
Craft skill type (V04)	Type of material culture change (V12)	26	0.001	0.749
Craft skills re-classed (V05)	Type of material culture change (V12)	26	0.050	0.427
Mode of transmission (V01)	Type of material culture change (V12)	26	0.614	0.348
Observation timescales (V13)	Type of material culture change (V12)	11	0.268	0.486
Observation timescales (V13)	Degree of conservatism (V02)	21	0.013	0.645
Settlement type (V14)	Degree of conservatism (V02)	67	0.273	0.277
Subsistence economy (V15)	Degree of conservatism (V02)	61	0.138	0.456
Kinship/residence (V16)	Degree of conservatism (V02)	12	0.408	0.239
Continent (V17)	Degree of conservatism (V02)	26	0.900	0.090
Latitude (V18)	Degree of conservatism (V02)	72	0.274	0.129

Table 3: Summary of X^2 analyses (statistically significant results, at α=0.05, are highlighted)

Where vertically-transmitted craft skills were associated with material culture innovations (predominantly through the 'mixed' categories), these patterns often reflected local, context-specific attitudes encouraging experimentation. For example, at Thimi and Bhaktapur in the Kathmandu Valley, India, potter knowledge is acquired by boys from their fathers, through vertical (parental) transmission. However, "there is no cultural pressure against innovation, in fact the reverse", and the potters consciously select from a very wide range of technical skills and use them "adventurously", resulting in a tradition of innovation in local pottery production (Birmingham 1975:381). In Chanal in the Mayan Highlands, new potters developed their own style over time, often resulting in very little resemblance between their work and that of their teachers, who were most commonly their mothers (Deal 1998:27).

2: Different craft skills (Craft skill type vs. Degree of conservatism): The different skills were not significantly conservative or innovative (Table 3)[ii], although the data did suggest conservative trends in lithic material culture and the possibility of innovative approaches to metalworking. These patterns are not especially robust, but may firstly reflect the absence of surface decoration and/or design patterns on lithics. Four of the six examples of innovation in basketry and weaving concern changes in designs, four of the 11 pottery examples include innovative decorations, and all four examples of innovation in metalworking (silversmithing) are in design and decoration. Surface design and decoration may be a more easily identified form of innovation on craft items, although it is clear that there can be a marked contrast between the perspectives of the archaeologists/anthropologists and the producers:

"Some forty-five or fifty Hopi decorative types (in the archaeological sense) could be calculated at a minimum; but they do not mean much, in behavioural terms, to the Hopi, who consider such technological factors as coiling, molding, scraping, smoothing, and firing to be vital, but see decoration, rim form, and the like as relatively unimportant matters of personal choice."

(Stanislawski 1978:215)

Secondly, of the six metalworking cases four are from the American southwest (silversmithing), and three of these four cases provide examples of innovation (including two by borrowing). The case studies indicate the impact of external, rather than domestic, market demands, and document the production of new products for the European markets (Adair 1945; Kluckholn 1946). The trend towards innovation in metalworking in these cases may therefore represent, at least in part, external market factors.

3: Social pressures & active corrections/sanctions (Social pressures? vs. Degree of conservatism): Unsurprisingly there is a marked relationship ($p=0.004$, Cramer's $V=0.671$; Table 3) between innovation (both through experimentation and borrowing) in craft skills and social attitudes in favour of experimentation and innovation (and vice-versa). More interestingly (and while acknowledging the sample size), the different social pressures are distributed across the vertical, master/apprentice and horizontal modes of transmission categories (Mode of transmission vs. Social pressures?; Table 3), suggesting that the presence/absence of such potentially important social pressures (with regard to craft skills development) cannot be predicted on the basis of the dominant mode of transmission, and may even act semi-independently of the prevalent learning and teaching mechanisms. By contrast, six of the seven examples of sanctions and active corrections were associated with conservatism in craft skills (and five examples occurred within vertical (parental) and/or oblique (elders) transmission), unsurprisingly suggesting that their presence is most commonly associated with the maintenance of existing traditions and 'accepted' ways of working.

4: Craft skill difficulty (Length of learning vs. Degree of conservatism; No. of production stages vs. Degree of conservatism; Table 3): The variation between conservatism and innovation in craft skills was considered in terms of the difficulty of learning and executing the craft skills, and the possible impact of variable difficulty levels upon the inclination or ability to innovate. Assessing these difficulty levels from the case studies was not straightforward, and two proxy measures were adopted: the length of the learning phase (or phases); and the number of individual production stages (i.e. the number of distinct processes that needed to be learned). No significant patterns were evident in the data when using either proxy, although this may reflect limitations in this data set, as previous studies (e.g. Roux 1990:143–145 & Fig. 2; Roux et al. 1995:78–81) have highlighted relationships between the length of time spent learning and the complexity of the motor skills to be acquired. In this regard it is perhaps interesting that the only examples of innovation in the data set used here (for which production stages data was available) were associated with the shortest number of production stages category: stone working in the Maya Highlands (Hayden 1987; Nelson 1987), weaving in Bonwire, Ghana (Lamb 1975), and pottery in Thimi and Bhaktapur, Kathmandu Valley, India (Birmingham 1975).

Nonetheless the absence in this study of significant associations between craft skill difficulty and conservatism/innovation may also follow previous work by Roux et al. (1995:81–83) and Dietler and Herbich (1998: 161), which noted that very high (Roux) or low (Dietler and Herbich) levels of individual expertise, rather than the general craft difficulty, were a key factor in promoting innovation.

5: Craftsmen and craftswomen (Same sex? vs. Degree of conservatism; Mode of transmission vs. Same sex?; Table 3): In the majority of cases (98%) where the necessary data was recorded (n=40), teacher and learner were the same sex, confirming the observations of Shennan and Steele (1999:376). There were no significant conservatism/innovation patterns in the male/female data (or any significant contrasts between the sexes with regard to the modes of transmission associated with their craft skills learning).

6: Types and timescales of change in material culture (Craft skill type vs. Type of material culture change; Craft skills re-classed vs. Type of material culture change; Mode of transmission vs. Type of material culture change; Observation timescales vs. Type of material culture change; Observation timescales vs. Degree of conservatism; Table 3): Types, forms, patterns, and decorations (n=20) and the techniques and technologies of production (n=5) were all used to identify change or similarity in the case study materials, raising three questions:

- Do technical changes occur less frequently in certain craft skills, and are they therefore under-represented in the case studies reported here?
- Are the techniques and technologies of craft production inherently stable (or at least more stable than the designs and forms of the end products)?
- Are ethnographic, ethnoarchaeological and anthropological studies bias against the recording of technical changes in craft production?

The analyses suggested that certain types of material culture change do occur less or more frequently in different craft skills ($p=0.001$, Cramer's $V=0.749$; $p=0.050$, Cramer's $V=0.427$; Table 3), with changes in forms over-represented amongst the weaving, carving and metalworking crafts, while technical changes were over-represented in the lithics and pottery crafts. However, since these two groups represent 54% (pottery and lithics) and 38% (weaving, carving and metalworking) of the case studies, it would appear that the apparent association between technical changes and pottery/lithic crafts does not explain the former's generally low presence (20% of all types of change) in the case study data. Technical innovations also occurred in association with vertical, master/apprentice and horizontal transmission, suggesting that while technical processes might be more stable than other types of material culture change (but see comments below) they can occur internally and do not always require horizontal transmission for their introduction (i.e. they are associated with innovation by both borrowing and experimentation).

Although the overall data suggest that technical changes are far less common than other types (e.g. changes in forms and patterns), it is possible that this represents problems of data collection. The duration of many research studies and field projects means that unless past techniques can be reconstructed from preserved artefacts or the tools used in manufacture, or from oral records, there is often no way of comparing contemporary, observed techniques with those from the past (although an increasing number of studies are successfully exploring and comparing technical variability, for example Gosselain 1992, 2000; Dietler and Herbich 1989, 1998; Roux et al. 1995). By contrast, comparisons of material culture can be made on the basis of preserved artefacts (including museum collections and historical illustrations or documents). There is also a lack of consistency in the case studies used in this study with regard to what is classified as conservatism/stability in material culture, and what is seen as innovation.

Interestingly, innovation cases are over-represented in the shortest timescale category, with conservatism cases over-represented in the middle and longer of the three categories ($p=0.013$, Cramer's $V=0.645$; Table 3). These patterns may reflect the way the cases were described however, since examples of conservatism in the case studies were often based on non-specific references to old "traditions" (e.g. from the previous century) or generic material culture comparisons. For example, van der Grijp (1995) argues that tapa producing techniques on Tonga have remained unchanged for centuries (although without including any direct comparisons of techniques), Allen (1983:165) notes that the potters of Zaria, Nigeria "have a skill that has been passed down over many generations in a relatively unchanged form as far as actual techniques are concerned", and Kramer (1997:169) makes reference to historical and archaeological assemblages when arguing that the modern Rajasthani potters produce vessels bearing stylistic and technological features stretching back millennia. By contrast, examples of innovation in the case studies are often based on specific material culture comparisons over shorter time-scales, for which explicit data are available, or anecdotal memories. For example, Hendry (1992) refers to the recent proliferation of pottery innovations at Atzompa, Mexico over the previous 50 years, while Hayden (1987) documents the introduction of metal stone-working tools and new techniques of quarrying into the stone tool production and mano and metate manufacturing traditions of the Maya Highlands, Guatemala, over 15–20 years (based on interviews with a local stone-worker).

Different timescales of observation may therefore have a significant impact upon the classification of material culture patterns as either conservatism or innovation. Amongst the Igbo in Nigeria (Nicholls 2000) girls learnt pottery production from their mothers, and 'traditional' methods were used. More

recently however, some of the villagers had been temporarily employed away from the village, in town-based western factories, where they had learnt to produce new forms. Upon their return to the villages, these new forms were introduced, and produced alongside the traditional forms. Moreover, these new forms were also adopted by those potters who had never worked in the factories. The key point is that over the timescales of Nicholls' study and observation, innovation (of new pottery forms) has clearly occurred through horizontal transmission (borrowing via the factory). It is interesting to speculate however, whether over 200 years and based on a fragmented and chronologically sporadic sample, one would be discussing conservatism, since the traditional forms continued to be produced and would indicate at least *some* long-term traditions in pottery production.

7. Analysis of the remaining variables (Tables 2 & 3) revealed no significant patterning.

4. Discussion

Vertical (parental) and horizontal modes of transmission showed clear associations with conservative and innovative patterns in craft skills' material culture respectively. However, other modes of transmission (oblique and master/apprentice, and where different modes were indiscriminately combined in the case study literature) showed less clear patterns: both conservatism and innovation were represented. Innovation through borrowing was, unsurprisingly, strongly correlated with horizontal transmission, with innovation through experimentation conversely associated with, and predominantly limited to, vertical, oblique, and/or master/apprentice transmission modes. There was only one example of horizontally transmitted innovation linked to experimentation, and only one example (amongst the Navajo weavers) of artisans learning from their elders and also showing a history of borrowing traits from neighbouring cultures).

There were relatively few distinctive associations between different craft skills and either patterning in material culture or the modes of transmission by which they were learnt. In other words, particular craft skills were no more conservative or innovative than others (whether defined by type or as additive or subtractive craft skills), and the majority of the skills appeared to be learnt through a variety of different transmission modes. However, the analyses also suggested the potential importance of other factors, including the case studies' frequent reliance on design and decoration as a means of defining innovation, and the role of market demands in craft innovation.

Social pressures, both pro and anti-innovation, unsurprisingly showed strong relationships with, respectively, patterns of innovation (both experimentation and borrowing) and conservatism in material culture. However, it was apparent that these social pressures could not be associated with specific modes of transmission: for example, anti-innovation social attitudes and pressures were not solely associated with vertical (parental) transmission. In short, social pressures were hard to predict, and required understanding of the specific cultures and contexts in which they existed. However, active corrections and sanctions were strongly associated with conservative patterns of material culture, and were linked to vertical (parental) and/or oblique (elders) modes of transmission.

While the different types of material culture innovation (e.g. in decorations or techniques) do not appear to vary by craft type (within the restrictions of the available data), it is suggested that changes in techniques and manufacturing practice do appear to occur less frequently. However, this may only reflect past difficulties of identifying such changes (e.g. in comparison with decorative changes in pottery) over the timescales of ethnoarchaeological studies for example, and the limitations of some of the data used here. It should also be noted that an increasing number of recent and current studies (see earlier references) are continuing to improve the available data in this regard.

Overall, it is clear from the case studies and the analyses that conservatism and/or innovation in material culture are potentially related to more than the modes of transmission associated with craft skills learning. For example, Graves' (1981) analysis of pottery production amongst the Kalinga concluded that other

factors than learning frameworks contributed to design variability, including the seasonality of production and the idiosyncratic tastes of the potter over time.

5. Archaeological Implications & Conclusions

The results summarised above have a number of potential implications for the analysis of material culture evolution and patterning in the archaeological record. While it is nearly always impossible to directly reconstruct modes of transmission for craft skills learning in archaeological cultures (due to the common absence of written sources), the clear patterning in the analyses (vertical transmission/conservative; horizontal transmission/innovation by borrowing) does offer an alternative approach. An index of connectivity for a particular archaeological community/region/culture could reveal relationships with the relative conservatism/innovation observed over time in the craft skills' material record(s). This assumes of course that the index is a measure of the degree of external contacts, and therefore of the potential for horizontal transmission (and borrowed/introduced innovations for example). Construction of the index would be challenging but could be based on settlement density values, the density of material culture variations, or regional inter-connectivity (utilising network analyses). Variations to the predicted patterns should be considered in terms both of additional factors (as discussed above) and the potential impacts of other modes of transmission (particularly oblique, master/apprentice and mixed modes of transmission).

Analysis of archaeological crafts should assume that different types are not more or less inherently conservative and/or innovative, and that different crafts are not associated with specific modes of transmission with regard to skills learning, although the great majority of craft skills in general are transmitted through vertical and oblique modes. However, it is clear that consideration should be given to our definition of innovation, and to the relative frequency and ease of identification of similarities and changes in decorations and designs (e.g. in pottery and weaving compared to those in lithics) or technical practices, following recent studies such as Gosselain (2000) and Dietler and Herbich (1989, 1998) amongst others. Finally, consideration should also be given to the role of market demands (the proximity of markets may also be identifiable in the archaeological record).

Variables such as frequency of production, craft skill difficulty, and material culture variability can be demonstrated in the archaeological record (e.g. frequency of production was demonstrated in the work of Shafer and Hester (e.g. 1986, 1991) regarding Maya stone tool production at Colha, while craft skill difficulty can be reconstructed from chaîne opératoire evidence (e.g. Edmonds 1990; Pigeot 1990). However the analyses reported here suggest that these factors do not appear to be important with regard to conservative or innovative trends in material culture patterning.

Social pressures, sanctions and active corrections are however clearly an important factor with regard to material culture patterning, and evidence from the chaîne opératoire (e.g. the repetitive use of a single manufacturing 'path' that was demonstrably not the most efficient option) and/or highly standardised end products could potentially be used to detect their presence in the archaeological record. This final point also serves as a valuable reminder that all attempts to explore patterns in archaeological material culture from the perspectives described in this paper must first consider the specific, local contexts of learning, production and use (e.g. Deal 1998; DeBoer 1984; Kramer 1997; Stanislawski 1977) which are critical to our understanding.

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Bibliography

Adair, J.
1945 *The Navajo and Pueblo silversmiths*. University of Oklahoma Press, Norman.

Allen, R.
1983 The Myth of a Redundant Craft: Potters in Northern Nigeria. *The Journal of Modern African Studies* 21(1):159–166.

Aronson, M. A., and P. Fournier
1993 Models for Technological Innovation: An Ethnoarchaeological Project in Pino Suarez, Mexico. In *The Social and Cultural Contexts of New Ceramic Technologies*, edited by W. D. Kingery, pp. 33–74. The American Ceramic Society, Westerville.

Balfet, H.
1981 Production and Distribution of Pottery in the Maghreb. In *Production and Distribution: a Ceramic Viewpoint*, edited by H. Howard and E. Morris, pp. 257–269. BAR International Series 120. BAR, Oxford.

Barrett, S. A.
1910 The Material Culture of the Klamath Lake and Madoc Indians of Northeastern California and Southern Oregon. *American Archaeology and Ethnology* 5(4).

Binford, L. R., and J. F. O'Connell
1984 An Alyawara Day: The Stone Quarry. *Journal of Anthropological Research* 40:406–432.

Birmingham, J.
1975 Traditional Potters of the Kathmandu Valley: An Ethnoarchaeological Study. *Man* 10(3):370–386.

Boesch, C.
1993 Aspects of transmission in tool-use in wild chimpanzees. In *Tools, Language and Cognition in Human Evolution*, edited by K. R. Gibson and T. Ingold, pp. 171–183. Cambridge University Press, Cambridge.

Boesch, C., and H. Boesch
1993 Diversity of tool use and tool-making in wild chimpanzees. In *The Use of Tools in Human and Non-human Primates*, edited by A. Berthelet and J. Chavaillon, pp. 158–174. Clarendon Press, Oxford.

Bowers, A. W.
1950 *Mandan Social and Ceremonial Organization*. The University of Chicago Press, Chicago.
1965 *Hidatsa Social and Ceremonial Organisation*. Smithsonian Institute, Washington.

Boyd, R., and P. J. Richerson
1985 *Culture and the Evolutionary Process*. University of Chicago Press, Chicago.
1988 An evolutionary model of social learning: the effects of spatial and temporal variation. In *Social Learning: Psychological and Biological Perspectives*, edited by T. R. Zentall and B. G. Galef, pp. 29–48. Lawrence Erlbaum, Hillsdale NJ.

Bray, J. M.
1969 The Craft Structure of a Traditional Yoruba Town. *Transactions of the Institute of British Geographers* 46:179–193.

Brower, B. A.
1987 *Livestock and landscape: the Sherpa pastoral system in Sagarmatha (Mt. Everest) National Park, Nepal*. Ann Arbor, Michigan.
1991 *Sherpa of Khumbu: people, livestock and landscape*. Oxford University Press, Oxford.

Cavalli-Sforza, L. L., and M. W. Feldman
1981 *Cultural Transmission and Evolution: A Quantitative Approach*. Princeton University Press, Princeton.

Centre for Women's Resources (Philippines)
1999 *A look at the world of indigenous women: research in selected areas of Ifugao, Maguindanao & Bacolod City*. Centre for Women's Resources, Quezon City.

Clarke, H. F.
1939 The Craft of Silversmith in Early New England. *The New England Quarterly* 12(1):68–79.

Deal, M.
1998 *Pottery ethnoarchaeology in the Central Maya Highlands*. University of Utah Press, Salt Lake City.

DeBoer, W. R.
1984 The Last Pottery Show: System and Sense in Ceramic Studies. In *The Many Dimensions of Pottery: Ceramics in Archaeology and Anthropology*, edited by S. E. van der Leeuw and A. C. Pritchard, pp. 527–571. Universiteit van Amsterdam, Amsterdam.

DeBoer, W. R., and D. W. Lathrap
1979 The Making and Breaking of Shipibo–Conibo Ceramics. In *Ethnoarchaeology: Implications of Ethnography for Archaeology*, edited by C. Kramer, pp. 102–138. Columbia University Press, New York.

Dietler, M., and I. Herbich
1989 Tich Matek: The Technology of Luo Pottery Production and the Definition of Ceramic Style. *World Archaeology* 21(1):148–164.
1998 Habitus, techniques, style: An integrated approach to the social understanding of material culture and boundaries. In *The Archaeology of Social Boundaries*, edited by M. Stark, pp. 232–263. Smithsonian Press, Washington DC.
Downs, J. F.
1972 *The Navajo*. Holt, Rinehart and Winston, New York.
Dransart, P.
1992 Fuegia Basket or the Life of a Basketmaker in Tierra del Fuego. In *Basketmakers: Meaning and Form in Native American Baskets*, edited by L. Mowat, H. Morphy, and P. Dransart, pp. 105–112. Pitt Rivers Museum, Oxford.
Edmonds, M.
1990 Description, Understanding and the *Chaîne Opératoire*. *Archaeological Review from Cambridge* 9(1):55–70.
Epstein, S. R.
1998 Craft Guilds, Apprenticeship, and Technological Change in Preindustrial Europe. *The Journal of Economic History* 58(3):684–713.
Ferg, A. (editor)
1987 *Western Apache Material Culture*. The University of Arizona Press, Arizona.
Ferg, A., and W. B. Kessel
1987 Subsistence. In *Western Apache Material Culture*, edited by A. Ferg, pp. 49–86. The University of Arizona Press, Arizona.
Firth, R.
1939 *Primitive Polynesian Economy*. George Routledge & Sons Ltd., London.
Goodwin, G.
1942 *The social organization of the Western Apache*. The University of Chicago Press, Chicago.
Gosselain, O. P.
1992 Technology and Style: Potters and Pottery Among Bafia of Cameroon. *Man* (N.S.) 27(3):559–586.
2000 Materializing Identities: An African Perspective. *Journal of Archaeological Method and Theory* 7(3):187–217.
Graves, M.
1981 *Ethnoarchaeology of Kalinga Ceramic Design*. PhD Dissertation. Department of Anthropology, University of Arizona. University Microfilms International, Ann Arbor, Michigan.
Guglielmino, C. R., C. Viganotti, B. Hewlett, and L. L. Cavalli-Sforza
1995 Cultural variation in Africa: Role of mechanisms of transmission and adaptation. *Proceedings of the National Academy of Sciences, USA* 92:7585–7589.
Haaland, R.
1985 Iron Production, its Socio-Cultural Context and Ecological Implications. In *African Iron Working — ancient and traditional*, edited by R. Haaland and P. Shinnie, pp. 50–72. Norwegian University Press, Oslo.
Handy, E. S. C.
1972 *Native planters in old Hawaii: their life, lore, and environment*. Bishop Museum Press, Honolulu.
Hartman, R. P.
1987 *Navajo pottery: traditions & innovations*. Northland Press, Flagstaff.
Hayden, B.
1987 Traditional Metate Manufacturing in Guatemala Using Chipped Stone Tools. In *Lithic Studies Among the Contemporary Highland Maya*, edited by B. Hayden, pp. 8–119. The University of Arizona Press, Tucson.
Hayden, B., and A. Cannon
1984 Interaction Inferences in Archaeology and Learning Frameworks of the Maya. *Journal of Anthropological Archaeology* 3:325–367.
Hayden, B., and M. Nelson
1981 The Use of Chipped Lithic Material in the Contemporary Maya Highlands. *American Antiquity* 46(4):885–898.
Hewlett, B. S., and L. L. Cavalli-Sforza
1986 Cultural Transmission among Aka Pygmies. *American Anthropologist* 88(4):922–934.
Hendry, J. C.

1992 *Atzompa: a pottery producing village of Southern Mexico in the mid-1950's*. Vanderbilt University, Nashville.

Hodder, I.

1981 Society, economy and culture: an ethnographic case study among the Lozi. In *Pattern of the Past: Studies in Honour of David Clarke*, edited by I. Hodder, G. Isaac, and N. Hammond, pp. 67–95. Cambridge University Press, Cambridge.

Howry, J. C.

1978 Ethnographic Realities of Mayan Prehistory. In *Cultural Continuity in Mesoamerica*, edited by D. L. Browman, pp. 239–257. Mouton Publishers, The Hague.

HRAF

2002, 24 September. *Human Relations Area Files*. http://www.yale.edu/hraf/ (June 2004).

Hurt, W. R.

1942 Eighteenth century Navaho hogans from Canyon de Chelly National Monument. *American Antiquity* 8:89–104.

Jones, R., and N. White

1988 Point Blank: stone tool manufacture at the Ngilipitji Quarry, Arnhem Land, 1981. In *Archaeology with Ethnography: an Australian Perspective*, edited by B. Meehan and R. Jones, pp. 51–87. The Australian National University, Canberra.

Jopling, C.F.

1977 Yalálag Weaving: Its Aesthetic, Technological and Economic Nexus. In *Material Culture: Styles, Organization and Dynamics of Technology*, edited by H. Lechtman & R. S. Merrill, pp. 211–236. West Publishing Company, New York.

Kent, K. P.

1985 *Navajo weaving: three centuries of change*. School of American Research Press, Santa Fe.

Kluckhohn, C.

1946 *The Navaho*. Harvard University Press, Cambridge.

Kok, R.

1979 *Ifugao Basketry*. Galerie Mabuhay, Amsterdam.

Kramer, C.

1985 Ceramic Ethnoarchaeology. *Annual Review of Anthropology* 14:77–102.

1997 *Pottery in Rajasthan: Ethnoarchaeology in Two Indian Cities*. Smithsonian Institution Press, Washington.

Kreamer, C. M.

2000 Money, Power and Gender: Some Social and Economic Factors in Moba Male and Female Pottery Traditions (Northern Togo). In *Clay and Fire: Pottery in Africa*, edited by C. D. Roy, pp. 189–212. University of Iowa, Iowa City.

Lamb, V.

1975 *West African Weaving*. Duckworth, London.

Lambrecht, F.

1958 Ifugao weaving. *Folklore studies* 17:1–53.

Lloyd, P.

1953 Craft Organisation in Yoruba Towns. *Africa* 23:30–44.

Longacre, W.

1981 Kalinga pottery: an ethnoarchaeological study. In *Pattern of the Past: Studies in Honour of David Clarke*, edited by I. Hodder, G. Isaac, and N. Hammond, pp. 49–66. Cambridge University Press, Cambridge.

MacKenzie, M. A.

1991 *Androgynous Objects: String bags and gender in central New Guinea*. Harwood Academic Publishers, Amsterdam.

Mashman, V.

1991 Warriors and weavers: a study of gender relations among the Iban of Sarawak. In *Female and male in Borneo: contributions and challenges to gender studies*, edited by V. H. Sutlive Jr., pp. 231–270. The Borneo Research Council, Inc., Williamsburg.

Mead, M.

1928 The Role of the Individual in Samoan Culture. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 58:481–495.

Nash, J. C.

1970 *In the eyes of the ancestors: belief and behaviour in a Mayan community*. Yale University Press, New Haven.

Nelson, M.
1987 Contemporary Specialization and Marketing of Manos and Metates in the Maya Highlands. In *Lithic Studies Among the Contemporary Highland Maya*, edited by B. Hayden, pp. 148–159. The University of Arizona Press, Tucson.
Newcomb, F. J.
1964 *Hosteen Klah: Navaho medicine man and sand painter*. University of Oklahoma Press, Oklahoma.
Nicholls, A.
2000 Local Pottery and Urban Ceramic Traditions in Certain Igbo Areas. In *Clay and Fire: Pottery in Africa*, edited by C. D. Roy, pp. 129–148. University of Iowa, Iowa City.
Ottenberg, S.
1975 *Masked rituals of Afikpo, the context of an African art*. The University of Washington Press, Seattle.
Pearsall, M.
1950 *Klamath childhood and education*. University of California Press, Berkeley.
Perry, R. J.
1991 *Western Apache Heritage: People of the Mountain Corridor*. University of Texas Press, Austin.
Pigeot, N.
1990 Technical and Social Actors: Flintknapping specialists at Magdalenian Etiolles. *Archaeological Review from Cambridge* 9(1):126–141.
Rattray, R. S.
1927 *Religion and art in Ashanti*. Clarendon Press, Oxford.
Roberts, H. H.
1929 *Basketry of the San Carlos Apache*. American Museum of Natural History, New York.
Robertson, S. M.
1961 *Craft and Contemporary Culture*. George G. Harrap & Co., London.
Roux, V.
1990 The Psychosocial Analysis of Technical Activities: a Contribution to the Study of Craft Specialisation. *Archaeological Review from Cambridge* 9(1):142–153.
Roux, V., B. Bril, and G. Dietrich
1995 Skills and Learning Difficulties Involved in Stone Knapping: The Case of Stone-Bead Knapping in Khambhat, India. *World Archaeology* 27(1):63–87.
Rowlands, M.
1993 The Role of Memory in the Transmission of Culture. *World Archaeology* 25(2):141–151.
Roy, C., B. Agunbiade, M. L. McNully, and C. Hindes
2000 Traditional Crafts in Contemporary Nigeria: Case Studies of Pottery Making in Ooko and Dada Compound (Ilorin), Southwestern Nigeria. In *Clay and Fire: Pottery in Africa*, edited by C. D. Roy, pp. 229–252. University of Iowa, Iowa City.
Sandin, B.
1980 *Iban adat and augury*. Penerbit Universiti Sains Malaysia, Penang.
Scoditti, G. M. G.
1982 Aesthetics: The Significance of Apprenticeship on Kitawa. *Man* 17(1):74–91.
1990 *Kitawa: a linguistic and aesthetic analysis of visual art in Melanesia*. Mouton de Gruyter, New York.
Shafer, H. J., and T. R. Hester
1986 Maya Stone–Tool Craft Specialization and Production at Colha, Belize: Reply to Mallory. *American Antiquity* 51(1):158–166.
1991 Lithic Craft Specialisation and Product Distribution at the Maya Site of Colha, Belize. *World Archaeology* 23(1):79–97.
Shennan, S. J.
2002 *Genes, Memes and Human History: Darwinian Archaeology and Cultural Evolution*. Thames & Hudson, London.
Shennan, S. J., and J. Steele
1999 Cultural learning in hominids: a behavioural ecological approach. In *Mammalian Social learning: Comparative and Ecological Perspectives*, edited by H. O. Box and K. R. Gibson, pp. 367–388. Cambridge University Press, Cambridge.
Silver, H. R.
1981 Carving up the Profits: Apprenticeship and Structural Flexibility in a Contemporary African Craft Market. *American Ethnologist* 8(1):41–52.
Silverman, R. A.

2000 Contemporary Pottery Production in Wolayta (Ethiopia). In *Clay and Fire: Pottery in Africa*, edited by C. D. Roy, pp. 169–188. University of Iowa, Iowa City.

Sinopoli, C. M.
1988 The Organisation of Craft Production at Vijayanagara, South India. *American Anthropologist* 90(3):580–597.

Stanislawski, M. B.
1977 Ethnoarchaeology of Hopi and Hopi-Tewa Pottery Making: Styles of Learning. In *Experimental Archaeology*, edited by D. Ingersoll, J. E. Yellen, and W. Macdonald, pp. 378–408. Columbia University Press, New York.
1978 If Pots were Mortal. In *Explorations in Ethnoarchaeology*, edited by R. A. Gould, pp. 201–227. University of New Mexico Press, Albuquerque.

Stanislawski, M. B., and B. B. Stanislawski
1978 Hopi and Hopi-Tewa ceramic tradition networks. In *The Spatial Organisation of Culture*, edited by I. Hodder, pp. 61–76. Duckworth, London.

Stark, M. T., and W. A. Longacre
1993 Kalinga Ceramics and New Technologies: Social and Cultural Contexts of Ceramic Change. In *The Social and Cultural Contexts of New Ceramic Technologies*, edited by W. D. Kingery, pp. 1–32. The American Ceramic Society, Westerville.

Tindall, B. A.
1976 Theory in the Study of Cultural Transmission. *Annual Review of Anthropology* 5:195–208.

Tippett, A. R.
1968 *Fijian Material Culture*. Bishop Museum Press, Honolulu.

Tobert, N.
1985 Craft Specialisation: A Seasonal Camp in Kebkebiya. *World Archaeology* 17(2):278–288.

Tolentino Jr., D.
2001 From Artefact to Art: Configuring the Material Culture of the Cordillera. In *Towards Understanding Peoples of the Cordillera (Volume 1)*, edited by Cordillera Studies Centre, pp. 198–210. Cordillera Studies Centre.

Tschopik, H.
1941 *Navaho pottery making: an inquiry into the affinities of Navaho painted pottery*. Peabody Museum of American Archaeology and Ethnology, Cambridge.

Van der Grijp, P.
1995 Made in Tonga: Manufacture and Art Objects from Leaves, Bark and Wood. In *Pacific Material Culture*, edited by D. A. M. Smidt, P. ter Keurs, and A. Trouwborst, pp. 200–218. Rijksmuseum voor Volkenkunde, Leiden.

Waane, S.
1977 Pottery-making traditions of the Ikombe Kisi, Mbeya Region, Tanzania. *Baessler-Archiv* 25(2):251–317.

Whiten, A.
2000 Primate Culture and Social Learning. *Cognitive Science* 24(3):477–508.

Wiessner, P.
1983 Style and Social Information in Kalahari San Projectile Points. *American Antiquity* 48(2):253–276.

Zingg, R. M.
1938 *The Huichols: Primitive Artists*. G.E. Stechert & Co., New York.

[i] This approach follows Longacre's (1981:61–63) detection of micro-traditions (reflecting vertical, mother–daughter transmission) and distinctive village styles amongst the Kalinga of northern Luzon in the Philippines.

[ii] Classifying the crafts according to whether they were additive or subtractive (Craft skills re-classed vs. Degree of conservatism) likewise did not produce a significant result (Table 3), and there was also no clear evidence that specific crafts were associated with specific modes of transmission (Mode of transmission vs. Craft skill type; Mode of transmission vs. Craft skills re-classed; Table 3): in other words, all of the craft skills were learnt in a variety of different ways.